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THE WORK OF THE YUMA RECLAMATION PROJECT EXPERIMENT FARM IN 1919 AND 1920

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Field of Brown kaoliang grown on the Yuma Experiment Farm in 1919

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PROGRESS OF AGRICULTURAL DEVELOPMENT.

The year 1920 marked the end of a 10-year period of agricultural development on the Yuma project. From statistics assembled by the United States Reclamation Service the annual growth of all lines of farming enterprises on the project is shown to have been exceedingly rapid. The area of all crops increased from 8,570 acres in 1911 to 54,484 in 1920 and the total farm values from $443,984 in 1911 to $7,012,209 in 1919. Throughout this period the important crops grown, considered on a basis of total acreage and listed in the order of their importance, have been cotton, alfalfa hay, alfalfa seed, grain sorghums, barley, and wheat.

The maximum values per acre and per unit of yield were obtained in the year 1919. The marked decrease in all farm values in 1920 compared with the previous year represents the general agricultural depression which has been experienced throughout the country.

From 1911 to 1916, inclusive, the growth of live-stock industries on the project was fairly rapid and substantial. Dairy cows, hogs, poultry, and bees constituted the important lines of live-stock production. The more profitable returns from the alfalfa-seed and cotton crops in the years following 1916 caused a gradual decrease in all live-stock farming except honey production.

THE YUMA RECLAMATION PROJECT.

The Yuma reclamation project embodies a total area of 110,000 acres, located in the States of California and Arizona near the international boundary. Of this area, 65,000 acres is valley land lying along the Colorado River, all of which is irrigable, and 45,000 is mesa land, which parallels the valley. The valley lands were originally covered with trees or bushy shrubs, which growth was maintained by the annual overflow of these areas by the Colorado River.

CONDITIONS ON THE PROJECT.

CLIMATIC CONDITIONS.

Weather conditions in 1919 and again in 1920 played an important part in the production of all crops.

The season of 1919 was characterized by ideal weather for spring seeding, a favorable growing period during the summer months, and an exceptionally early killing frost (October 29). The frost-free period of 233 days for the year is the shortest recorded during the 10 years. This early freeze greatly reduced the cotton yields on the project, and as this crop occupied a large acreage and was selling for high prices the total financial loss was very serious.

The year 1920 had a growing season, or frost-free period, of 345 days. This is the longest period recorded at this station. The last killing frost in the spring occurred on January 16; however, cool and windy weather continued far into the planting season. Replanting cotton several times was not uncommon and this crop in general made a late start. The cool spring weather also had a detrimental effect on the alfalfa-seed crop. The seed did not develop as in normal years and the average yield per acre was unusually low. Cotton yields were furthermore reduced by aphis injury and by the shedding of squares and young bolls during the latter part of July and the early part of August. A late killing frost which held off until November 25 made it possible for most of the top crop of cotton to mature.

The highest temperature recorded for each of the two years was the same, 114° F. The lowest temperature in 1919 was 17.5° F. and in 1920 24° F. The mean temperatures were approximately normal when compared with the 10-year average.

Data covering the precipitation, evaporation, wind velocity, temperature, and dates of killing frosts for the years 1919 and 1920, with an average of the previous years, are presented in Table 1.

TABLE 1.—*Summary of meteorological observations at the Yuma Experiment Farm for the 10-year period from 1911 to 1920.*

PRECIPITATION (INCHES).

Year, etc.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Average for 10-year period	0.87	0.38	0.39	0.12	0.08	0.06	0.36	0.51	0.24	0.28	0.27	0.26	3.84
For 1919	.25	.04	.60	.....	.....	.....	.15	.54	.....	.20	.59	.08	2.45
For 1920	1.55	1.06	.31	.....	.....	.....	.02	1.05	1.31	.12	.....	.....	5.42

EVAPORATION (INCHES).

Average for 10-year period	2.78	3.61	5.90	7.38	9.17	9.90	9.64	8.72	7.00	5.41	3.60	2.63	75.87
For 1919	2.93	3.45	4.98	7.62	9.10	9.97	9.53	8.23	6.85	5.27	3.22	2.91	74.17
For 1920	1.85	2.43	5.22	8.07	8.63	9.55	9.96	8.27	6.38	5.18	2.79	2.50	70.83

DAILY WIND VELOCITY (MILES PER HOUR).

Average for 10-year period	2.5	2.7	2.9	3.0	2.7	2.1	1.9	1.6	1.4	1.7	2.0	2.2	.....
For 1919	1.7	2.1	1.9	1.9	1.6	1.5	1.5	.9	1.2	1.2	1.5	2.0	.....
For 1920	1.4	1.1	2.2	3.1	1.7	1.6	1.3	1.3	1.2	1.4	1.0	1.4	.....

TEMPERATURE (°F.).

Absolute maximum:													
For 10-year period	84	88	99	102	105	117	116	115	113	109	94	82	.....
For 1919	75	78	88	99	100	114	110	112	107	93	84	79	.....
For 1920	79	79	86	94	105	111	114	112	106	94	82	74	.....
Absolute minimum:													
For 10-year period	16	26	29	34	33	43	55	51	44	31	26	16	.....
For 1919	17	28	29	41	50	51	67	51	60	31	26	26	.....
For 1920	30	33	34	38	45	55	60	59	40	36	31	24	.....
Mean:													
For 10-year period	53.0	56.0	60.9	66.5	71.8	81.7	88.0	86.4	80.8	69.4	59.5	51.2	.....
For 1919	51.7	53.0	58.0	69.4	73.9	82.4	89.2	85.0	83.1	66.1	57.0	55.0	.....
For 1920	53.8	58.6	58.7	64.4	73.3	80.8	89.2	86.6	76.7	66.7	57.6	52.4	.....

KILLING FROSTS.

Year.	Last in spring.		First in autumn.		Frost-free period.
	Date.	Minimum temperature.	Date.	Minimum temperature.	
		°F.		°F.	*Days.*
1911	Feb. 24	32	Nov. 24	32	262
1912	Mar. 31	32	Dec. 4	31	247
1913	Mar. 28	32	Dec. 2	31	248
1914	Mar. 4	31	Dec. 4	32	275
1915	Mar. 3	31	Nov. 13	31	254
1916	Mar. 25	31.5	Nov. 17	31	237
1917	Mar. 13	30	Nov. 29	32	260
1918	Feb. 19	29	Nov. 7	29.5	261
1919	Mar. 9	31	Oct. 29	31	233
1920	Jan. 16	32	Nov. 25	32	345

IRRIGATION DEVELOPMENT.

During the two years 1919 and 1920 the total area cropped under irrigation on the Yuma project increased from 45,049 acres to 54,484, or 21 per cent. The increase in the number of farms during the same period was only 45, or less than 4 per cent.

It is to be noted that the cropped acreage per farm has shown a marked increase since 1912 (Table 2).[1] In that year the cropped acreage per farm was about 23 acres, while in 1920 it was slightly over 44 acres.

The proportion of farms operated by tenants has not changed materially in the last three years. There has been a marked improvement in the use of irrigation water. During the past two years the water delivered to farms has been slightly less than 3 acre-feet per acre irrigated.

TABLE 2.—*Summary of irrigation development on the Yuma Reclamation Project during the 9-year period from 1912 to 1920, inclusive.*

Items of comparison.	1912	1913	1914	1915	1916
Water diverted.....acre-feet..	96,409	127,307	205,207	246,786	249,700
Water delivered:					
To farms.....do....	63,273	85,411	93,167	92,897	94,393
Per acre irrigated.....do....	7	4.36	3.69	3.34	3.20
Length of canals operated.....miles..	173	227.5	249.5	307.3	316
Land area:					
Irrigable.....acres..	38,500	50,000	60,000	72,440	72,440
Irrigated.....do....	13,767	19,607	25,207	27,857	29,483
Cropped.....do....	11,060	16,726	22,568	25,101	28,283
Irrigated farms.....number..	470	616	698	737	790
Average population per farm.....	3.2	2.7	3.6	2.8	2.6
Total population on farms.....	1,490	1,793	1,815	2,036	2,002
Owners on farms.....	.....	496	468	659	453
Tenants on farms.....	.....	120	129	249	297
Value of crops:					
Total.....dollars..	497,103	610,228	709,409	873,721	1,435,403
Per acre cropped.....do....	44.90	36.48	31.43	34.43	50.00
Per farm.....do....	1,057.50	993.00	1,016.00	1,185.51	1,816.90
Value of live stock per farm.....do....	952.00	1,250.00	1,201.00	1,071.80	1,018.80

Items of comparison.	1917	1918	1919	1920
Water diverted.....acre-feet..	337,597	314,900	478,185	321,905
Water delivered:				
To farms.....do....	136,541	150,229	155,417	160,330
Per acre irrigated.....do....	3.7	3.3	2.92	2.94
Length of canals operated.....miles..	335	338	338	340
Land area:				
Irrigable.....acres..	72,440	73,000	62,000	62,000
Irrigated.....do....	36,956	45,670	53,284	54,550
Cropped.....do....	35,578	45,049	52,324	54,484
Irrigated farms.....number..	900	1,185	1,225	1,230
Average population per farm.....	3.0	3.67	4.1	4.1
Total population on farms.....	2,700	4,300	5,025	5,100
Owners on farms.....	505	700	723	711
Tenants on farms.....	339	485	502	519
Value of crops:				
Total.....dollars..	3,752,669	5,105,132	7,012,209	3,770,956
Per acre cropped.....do....	105.47	113.32	134.01	69.21
Per farm.....do....	4,169.52	4,308.13	5,724.25	.....
Value of live stock per farm.....do....	905.46	707.96	697.00	585.00

The first unit of the Yuma Mesa, containing about 6,400 acres of public land subdivided into about 500 farms ranging from 5 to 20 acres each, was sold at public auction at Yuma, Ariz., in December, 1919. The excavation work on the main canal and laterals to irrigate this area was mostly completed during the fall of 1920. Work on

[1] The figures in Tables 2, 3, 4, and 5 have been taken from the annual crop reports and schedules collected by the local office of the United States Reclamation Service. The writer wishes to express his indebtedness for the privilege of using these records.

the power pumps at the edge of the mesa was pushed so that water could be delivered to the land by the end of the year 1921.

The construction of large open drains on the project is being continued in the district north and east of Somerton and south of Gadsden. The seeped condition of a few farms adjacent to the river levees at Bard and at Gadsden became acute during the flood period in 1920.

CROP CONDITIONS.

The production of alfalfa hay, alfalfa seed, and cotton had been so stimulated by high prices during 1919 and the early part of 1920 that the acreage devoted to these crops in the latter year comprised approximately 93 per cent of the total irrigated area. This condition meant that the production of grain sorghums, winter grain, and miscellaneous crops was greatly reduced and that most of the newly cleared and leveled land was used for one of the three main crops.

The yields and values of all farm crops for the years 1919 and 1920 are shown in Table 3.

TABLE 3.—*Yields and farm value of crops grown on the Yuma Reclamation Project in 1919 and 1920.*

Crop.	Area (acres).	Unit of yield.	Yields.		Farm values.		
			Total.	Average per acre.	Per unit of yield.	Total.	Average per acre.
1919.							
Alfalfa hay	11,925	Ton	31,773	2.66	$19.15	$608,558	$51.03
Alfalfa seed	6,425	Pound	2,350,385	366	.297	698,164	108.66
Grain sorghums	5,134	Bushel	160,821	31.3	1.09	175,900	34.26
Cotton:							
Upland	30,670	Pound	10,957,900	357	.42	4,602,318	150.06
Pima	275	do	69,550	253	.80	55,640	202.33
Seed		Ton	10,850		60.00	651,000	21.04
Pasture	3,131	Acre				62,480	19.96
Barley	523	Bushel	11,806	22.5	1.28	15,114	28.70
Wheat	764	do	15,940	21.0	2.00	31,931	41.79
Garden	305	Acre				24,895	81.62
Fruit	66	do				11,420	173.03
Cane and corn fodder	139	Ton	482	3.47	12.79	6,167	44.37
Hay, except alfalfa	811	do	1,039	1.28	19.14	19,887	24.52
Less duplications	[a] 7,844						
Additional revenue						[b] 48,735	
Total cropped	52,324					7,012,209	
Average							134.01
1920.							
Alfalfa hay	13,000	Ton	28,862	2.22	19.34	558,160	42.93
Alfalfa seed	9,830	Pound	2,395,013	244	.27	646,920	65.81
Grain sorghums	2,300	Bushel	63,200	27.5	1.13	71,330	31.02
Cotton:							
Upland	27,600	Pound	9,870,000	358.0	.14	1,381,800	50.07
Pima	10,000	do	1,378,000	139.0	.56	771,680	77.17
Seed		Ton	13,000		15.00	195,000	5.19
Pasture	1,815	Acre				45,400	25.00
Barley	130	Bushel	2,489	19.3	1.22	3,040	23.56
Wheat	51	do	888	17.4	2.70	2,400	47.06
Garden	206	Acre				23,180	112.53
Fruit	110	do				10,600	97.29
Cane and corn fodder	84	Ton	118	11.4	17.54	2,070	24.64
Hay, except alfalfa	142	do	253	1.8	14.09	3,560	25.07
Less duplications	[a] 10,800						
Additional revenue						[b] 45,000	
Total cropped	54,480					3,770,940	
Average							69.20

[a] Duplicated areas resulting from growing grass and grain on the same land, from raising crops in bearing orchards, and from other similar methods of cropping.

[b] From feeding alfalfa straw and pasturing stalk lands.

While alfalfa continued to be an important crop on the Yuma project during the past three years, it has not occupied first place in point of acreage, having been displaced by cotton. The production of alfalfa seed, which has been an important industry since 1913, has continued to expand. Owing chiefly to high prices in 1919, the production of seed was highly profitable that year, and the acreage harvested for seed in 1920 was largely increased.

Alfalfa production on the project, both for hay and for seed, is based on the growing of three varieties or types: Hairy Peruvian, smooth Peruvian, and Chilean, or Arizona common. A field of alfalfa in the lower Yuma Valley which has been cut for seed is shown in Figure 1.

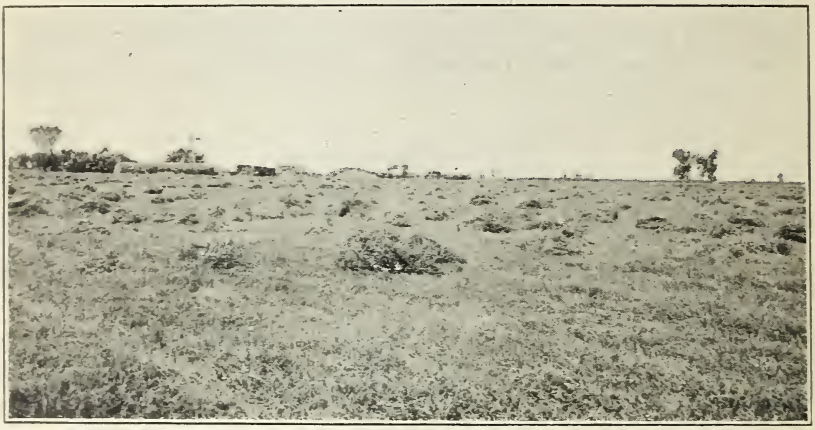

FIG. 1.—A field of alfalfa in the lower Yuma Valley which has been cut for seed.

The history of the Peruvian alfalfa industry in the United States[2] shows that the first introduction of seed from Peru was made by the Department of Agriculture in 1899. A number of tests which were subsequently made indicated that this alfalfa was well adapted to the irrigated regions of the Southwest.

Peruvian alfalfa was first grown on the Yuma project in 1906. Owing to its scarcity and an increasing demand for seed of this new variety, another importation from Peru was made in 1908. It was soon observed that the seed from this later importation produced a different type of plant, and in order to distinguish it from the earlier introduction the former was called hairy Peruvian and the latter smooth Peruvian.

The Chilean alfalfa, which was brought into California about the middle of the nineteenth century, was the most popular variety grown in the Southwest prior to the year 1900. The seed of this alfalfa produced on the project has given favorable results when planted in

[2] Woodward, H. L. The development of the Peruvian alfalfa industry in the United States. U. S. Dept. Agr. Circ. 93, 8 p., 2 fig. 1920.

the Northern and Eastern States, and a reputation for Yuma seed has been developed in these sections.

A phenomenal increase in the cotton acreage was made in each of the last four years. Occupying 36 per cent of the cultivated area in 1917, it was increased to 63 per cent in 1918, was 59 per cent in 1919, and reached 69 per cent in 1920. There was a decrease of approximately 3,000 acres of Upland cotton in 1920; however, the activities of the automobile-tire manufacturers during the fall of 1919 and the spring of 1920 stimulated the production of Pima cotton to such a degree that the acreage of this crop increased from 275 acres in 1919 to 10,000 in 1920. When it is considered that the area of land devoted to alfalfa should total from 30 per cent to 40 per cent of the entire cultivated area in order to maintain soil fertility through a proper rotation of crops, it is very evident that the cotton acreage on the Yuma project has been too large. This abnormal condition, in association with the unsettled and uncertain marketing problems which influenced the returns from cotton, tended to reduce the acreage planted in 1921.

The grain sorghums grown in this area in recent years were mostly Dwarf milo, Dwarf hegari, and feterita. The 5,134 acres planted in 1919 and 2,300 in 1920 did not produce a sufficient quantity of grain to meet the local needs. In many cases the grain sorghums were planted as a catch crop following a poor stand of cotton or after the harvesting of a winter grain crop.

Common Coast barley is the principal winter grain crop on the project. This is seeded in the fall as a nurse crop with new alfalfa, in renovated old alfalfa lands, or seeded alone in the regular manner. In many cases the crop is cut for hay. The area devoted to wheat during the two years has been greatly reduced. Small patches around the farmsteads for poultry comprise most of the plantings. The leading varieties of wheat grown are the Sonora and Early Baart. Some few fields of Texas Red oats have grown for hay. In the spring of 1919 a few acres of flax were harvested.

Winter grains in general should fill an important place in a permanent system of agriculture on the project. When planted early and harvested for grain, profitable returns should be received wherever a diversified system of farming, including live-stock production, is practiced. These grains are also valuable when included in a general rotation plan of crops. When planted on fall-plowed alfalfa stubble, the grain harvested in May, and the land again plowed and planted to grain sorghums, two beneficial results have been obtained. In one case the growth of Bermuda grass has been checked by the early-fall and late-spring shading effect of the winter grain, and in like manner the sorghum crop controls this pest during the summer months. Also plowing in the fall, followed by another plowing in the spring when the grain is harvested, results in

killing all volunteer alfalfa plants. This leaves the ground free from all weed pests. A winter legume may then be planted after the sorghum crop or the land fallowed until cotton is put in the next spring.

TABLE 4.—*Acreage, production, and farm values of the principal crops grown on the Yuma Reclamation Project in the 10-year period from 1911 to 1920, inclusive.*

Item and year.	All crops.	Alfalfa hay.	Alfalfa seed.	Grain sorghums.	Wheat and barley.	Cotton.[a]
Acreage:						
1911	8,570	3,750	[b] 2,600	420	1,290	30
1912	11,060	7,269	2,824	986	1,567	25
1913	16,726	10,321	3,388	2,928	1,586	62
1914	22,568	10,426	5,485	3,066	2,223	2,268
1915	25,101	9,441	6,449	6,408	3,838	709
1916	28,283	10,880	8,100	4,897	1,651	4,670
1917	35,578	12,901	4,643	6,883	900	12,706
1918	45,049	8,929	4,577	4,118	885	28,608
1919	52,324	11,925	6,425	5,134	1,287	30,945
1920	54,484	13,000	9,832	2,300	180	37,600
Production:		*Tons.*	*Pounds.*	*Bushels.*	*Bushels.*	*Pounds.*
1911		16,327	576,730	13,106	39,083	15,000
1912		27,078	814,186	31,372	55,375	5,800
1913		38,100	1,139,100	112,597	45,075	19,610
1914		32,525	1,246,318	100,153	61,674	845,044
1915		24,277	1,669,020	231,185	88,182	359,850
1916		28,029	2,635,800	195,799	35,306	2,289,430
1917		43,177	1,588,500	280,539	25,057	5,253,454
1918		28,695	1,690,352	174,631	21,396	10,854,525
1919		31,773	2,350,385	160,821	27,746	11,027,450
1920		28,862	2,396,013	63,200	3,377	11,248,000
Average yield per acre:						
1911		4.36	222	31.5	30.6	500
1912		3.73	288	31.8	35.3	232
1913		3.69	336	38.5	38.4	316
1914		3.12	227	32.6	27.8	373
1915		2.57	258.6	36.1	22.9	507.6
1916		2.58	325.2	39.97	21.39	490
1917		3.3	342	40.00	27.84	413.5
1918		3.21	369.3	42.40	24.18	379.4
1919		2.66	366	31.30	21.50	356.35
1920		2.22	244	27.50	18.70	299.14
Farm values per unit of yield:						
1911		$15.00	$0.16	$0.854	$0.66	$0.20
1912		10.00	.10	.75	.75	.20
1913		7.53	.111	.513	.668	.21
1914		6.05	.13	.70	.676	.08
1915		7.15	.1475	.63	.739	.109
1916		9.52	.1247	.64	.835	.174
1917		15.00	.1655	1.00	1.22	.366
1918		19.35	.23	1.04	1.68	.294
1919		19.15	.297	1.09	1.69	.422
1920		19.34	.27	1.13	1.61	.191
Farm values per acre:						
1911	$51.80	65.44	32.52	23.62	20.20	100.00
1912	44.94	37.30	28.80	23.85	26.47	46.40
1913	36.48	27.83	37.33	19.72	18.95	66.50
1914	31.43	18.86	29.15	23.13	21.13	30.80
1915	34.81	18.36	38.66	22.61	16.97	61.59
1916	50.75	24.53	40.58	25.50	17.84	100.15
1917	105.47	49.63	56.62	40.84	34.09	179.51
1918	113.32	63.31	83.06	44.04	40.64	133.14
1919	134.01	51.03	108.66	34.26	36.55	150.52
1920	69.21	42.93	65.88	32.02	32.28	57.27
Total farm values:						
1911	443,984	244,905	92,276	11,180	25,775	3,000
1912	497,103	270,780	81,418	23,529	41,517	1,160
1913	610,228	287,195	126,450	57,740	30,131	4,123
1914	709,409	196,716	159,806	70,915	41,373	78,399
1915	873,721	173,297	249,331	144,892	65,135	39,271
1916	1,435,403	266,898	328,725	124,915	29,465	467,697
1917	3,752,669	642,870	262,928	281,120	30,680	2,280,823
1918	5,105,132	565,322	380,216	181,361	35,956	3,159,634
1919	7,012,209	608,558	698,164	175,900	47,045	4,657,958
1920	3,770,956	558,164	646,918	71,333	5,441	2,153,480

[a] Acre values and total farm value of cotton include both fiber and seed.
[b] This area is included in the alfalfa-hay acreage for 1911.

Miscellaneous crops grown on a small scale consist of Sudan grass, sugar cane, forage sorghums, cowpeas, peanuts, beans, deciduous fruits, dates, and vegetables.

Statistics covering the acreage, production, and value of the five principal crops grown on the project for the 10-year period from 1911 to 1920, inclusive, are shown in Table 4.

LIVE-STOCK INDUSTRIES.

The rapid development in those branches of farming which deal with specialized field crops has caused a very serious decrease in live-stock production on the project. The number of horses and mules, in relation to the total acreage under cultivation, has remained fairly constant for each year, but other live-stock industries, dairy and beef cattle, hogs, and sheep, have shown a gradual decline in numbers. The decrease, according to the reports of the United States Reclamation Service, for the 2-year period of 1919 and 1920 is shown to be: Dairy cattle, 21 per cent; beef cattle, 30 per cent; hogs, 30 per cent; and sheep, 20 per cent. This reduction, however, has been accompanied by an improvement in the grade or quality of the retained live stock.

The pasturing of cattle and hogs on alfalfa is a practice that is generally followed. The long growing season of alfalfa in this climate and also the benefits derived from pasturing in maintaining the fertility of the soil combine to make this system of farming highly advantageous. Bermuda pasture and standing stalks on grain-sorghum lands are utilized as a source of cheap feed.

Sheep raising is confined to small farm flocks which are pastured on ditch banks to keep down the growth of weeds and grass.

An inventory of all live stock on the Yuma project for each year from 1911 to 1920, inclusive, is presented in Table 5.

It is impossible to obtain from Table 5 an accurate idea as to the extent of all live-stock production for any given season, because these figures represent only the number of animals on hand at the end of each year. An annual comparison is afforded, however, between the various divisions of the industry.

Figures covering the poultry industry are shown to be fairly consistent from one year to another. Ostrich farming in the past has been listed as one of the minor industries, but has now been practically abandoned. A new enterprise, although not included in Table 5, is the raising of goats for milk production.

The growing demand for honey is evidenced by the increase in the number of bee colonies on the project. This increase since 1918 amounts to about 100 per cent.

TABLE 5.—*Inventory of live stock on hand on the Yuma Reclamation Project at the close of each year for the 10-year period from 1911 to 1920, inclusive.*

Live stock.	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920
Number:										
Horses	1,570	1,705	2,111	2,465	2,898	2,950	3,223	3,841	3,609	3,433
Mules	362	440	560	544	612	756	933	1,309	1,258	1,372
Beef cattle	a 967	a 1,197	a 3,900	2,851	3,446	2,251	1,740	573	757	401
Dairy cattle				2,043	2,249	2,234	1,875	1,543	1,343	1,215
Sheep	.....	.....	.....	1,384	1,251	702	797	934	902	747
Hogs	1,767	2,634	2,886	4,982	12,500	13,688	8,136	2,421	2,384	1,680
Ostriches	40	121	184	193	121	91	70	50	50	.....
Fowls	22,857	25,646	27,882	35,935	50,723	43,361	27,537	30,286	41,852	30,815
Bee colonies	2,433	2,542	2,712	4,062	2,480	4,569	2,104	4,178	6,000	8,000
Average value per head or unit:										
Horses	$106.00	$107.52	$105.00	$99.48	$90.20	$100.75	$103.43	$104.23	$102.60	$89.13
Mules	128.00	127.33	150.00	138.37	126.86	117.02	132.27	145.01	124.07	109.05
Beef cattle	a 51.40	a 49.52	a 58.00	37.68	44.46	43.04	55.81	57.19	45.86	57.87
Dairy cattle				81.42	73.02	41.40	66.69	69.86	108.55	82.83
Sheep	.....	.....	.....	4.65	4.69	7.85	10.97	9.92	9.78	7.36
Hogs	7.15	9.07	8.65	7.60	6.49	7.90	10.42	15.09	14.41	13.17
Ostriches	315.00	186.95	145.00	5.57	5.83	17.69	50.00	10.00	10.00	.....
Fowls	.64	.65	.62	.79	.65	.78	.94	.94	1.07	1.07
Bee colonies	3.15	3.21	4.00	4.80	4.84	3.40	6.83	7.50	10.00	10.00
Total value:										
Horses	166,389	183,364	221,525	245,227	261,410	295,245	333,351	400,367	370,287	305,985
Mules	46,340	56,030	84,329	75,272	77,640	88,470	123,417	189,825	156,080	150,230
Beef cattle	a 49,705	a 59,270	a 224,251	107,434	153,906	96,873	96,981	32,772	34,710	23,205
Dairy cattle				166,335	164,235	159,505	125,055	107,800	145,785	100,642
Sheep	.....	.....	.....	6,432	5,868	5,513	8,740	9,265	8,825	5,505
Hogs	12,627	23,903	24,965	37,848	81,122	108,183	85,805	36,552	34,354	22,117
Ostriches	12,600	22,625	26,610	1,075	705	1,610	3,500	500	500	.....
Fowls	14,559	16,578	17,180	28,342	32,936	33,923	25,702	29,456	45,055	32,853
Bee colonies	7,674	8,159	10,832	19,499	12,002	15,565	13,370	32,400	60,000	80,000
Total	309,934	369,929	609,692	687,484	789,824	804,887	815,921	838,937	855,096	720,537

a Beef and dairy cattle for 1911, 1912, and 1913 were not segregated.

DISEASES AND PESTS.

Plant diseases.—During the years 1919 and 1920 there was no serious outbreak of any plant disease. Cotton root-rot was reported in nearly all sections of the project, but so far it has been confined to small areas.

Small losses occur to the grain crops, due to rusts and smuts. The small acreage planted and the more careful methods of treating the seed have reduced materially the total loss caused by these diseases.

The fruit diseases most frequently reported in the past have been the mildew of grapes, the fermenting fungus of dates, and an unidentified fungus which affects the pomegranates. The grape mildew may be controlled by spraying the vines two or three times with powdered sulphur. The first spraying should be applied at about the time growth starts in the spring, the second at the time of blooming, and the third, if necessary, when the grapes begin to ripen.

Insect pests.—Serious damage was caused during the two years by the cotton aphis. Spraying with a nicotine sulphate solution (40 per cent nicotine) with soap and water was attempted in badly infested districts.

Plant bugs, especially the cotton stainers, caused some loss in all sections of the project.

The alfalfa butterly, the alfalfa-seed chalcis fly, grasshoppers, spring-grain aphis, plant lice, thrips, leaf hoppers, red spiders, salt-marsh caterpillar, wireworms, corn earworms, cotton-leaf perforator, and ants have been reported in various localities.

Quarantine regulations to prevent the introduction of serious insect pests are enforced by the Arizona Horticultural Commission. As Yuma, Ariz., is the point of entry for practically all shipments of the project, a special officer stationed there inspects all shipments of plants and seeds not only for Yuma County but also for the Yuma project, a part of which lies in California.

This service to the farmers has been very valuable in preventing the introduction of the boll weevil and pink bollworm of cotton, the various scales of citrus fruits, the alfalfa weevil, the crown-gall of fruit trees, the phylloxera of grapevines, and all other insects against which quarantine regulations have been maintained.

Bird and animal pests.—The injury by birds to winter grains, grain sorghums, and fruit crops is quite serious in some sections. Early-maturing varieties are usually damaged more than those which ripen later in the season.

Weed pests.—The number of weed pests which injure field crops on the project does not seem to vary from year to year. Those having seed which become mixed with alfalfa seed and on that account are considered to be the most serious are Johnson grass (*Holcus halepensis*), sour clover (*Meliotus indica*) and, to a limited extent, dodder (*Cuscuta arvensis.*) In the cultivated crops Bermuda grass (*Capriola dactylon*) is the worst pest. The sand bur (*Cenchrus* sp.), although confined to small areas at present, has caused trouble in the cotton and alfalfa fields.

ECONOMIC CONDITIONS.

The general prosperity enjoyed during the season of 1919 was reflected in the number of improvements to private and public property on the project. Many new and more permanent farm buildings were erected. Construction work on two large public-school buildings was begun, and bonds were voted for additional paved roads in the Yuma Valley. During the 2-year period with which this report deals there were constructed at various project points three additional saw gins and two of the roller type.

Land values responded to the upward trend of all farm products in 1919. The price of improved land rose from about $250 per acre in 1918 to around $500 the following year. This period of high valuation continued until late in the spring of 1920. The financial crisis and the sluggish market for all farm products reduced land values during the latter year below the $300 mark.

During the recent period of agricultural expansion which was reflected in this increase in land values, much farming land was rented for short terms, particularly for cotton production. Many of the renters were inadequately equipped both as to capital and experience, with the result that their operations were conducted at a serious disadvantage. In many cases the temporary character of the enterprise necessitated the use of makeshift buildings, and often the final result was the loss of the original investment with but small returns for the labor expended.

The active organizations on the project which are interested in the welfare of unit holders are the Yuma Valley Water-Users' Association, the Yuma Valley Produce-Growers' Association, and the county organizations of the American Farm Bureau Federation.

THE YUMA EXPERIMENT FARM.[3]

The work of this experiment farm is devoted chiefly to the production and utilization of a wide range of irrigated farm crops. The problems investigated include variety tests, cultural methods, time and rate of seeding tests, breeding and selection work with the principal crops, and live-stock pasturing. The results of these experiments are applicable to the major agricultural industries of the Yuma Reclamation Project and also to the adjacent irrigated valleys in the Southwest.

CROP EXPERIMENTS.

Some of the important long-term experiments which were begun in the past years were continued during 1919 and 1920. In addition to the general line of tests made each year many new varieties and species of plants which merit investigation are included.

The principal experiments conducted during the last two years were the cultural and varietal tests of cotton, the selection and increase of the stocks of Durango and Tuxtla cotton, cultural and varietal tests and the breeding of alfalfa, varietal tests and the breeding of sorghums, varietal tests of barley, wheat, and flax, the testing of miscellaneous forage crops, deciduous-fruit and grape investigations, fruiting tests of the various small fruits, the fruiting of seedling dates, figs, and pomegranates, the culture of truck crops, the adaptability of ornamental trees and shrubs, and the pasturing of hogs on alfalfa.

Figures 2 and 3 show the arrangement of the fields and the location of the crops in 1919 and 1920.

[3] The Yuma Experiment Farm, which includes 160 acres, is located on the Yuma Reclamation Project and adjoins the town site of Bard on the California side of the Colorado River. The work of the farm is under the immediate supervision of the Office of Western Irrigation Agriculture, while arrangements are provided for some special experiments under the direction of representatives of other offices of the Bureau of Plant Industry.

COTTON.[4]

VARIETY TESTS.

Beginning with the year 1916 there has been conducted at this station a test of most of the cotton varieties which are commercially important in the United States. Only small lots of seed are obtained for this work, and while these tests are made on small plats and are

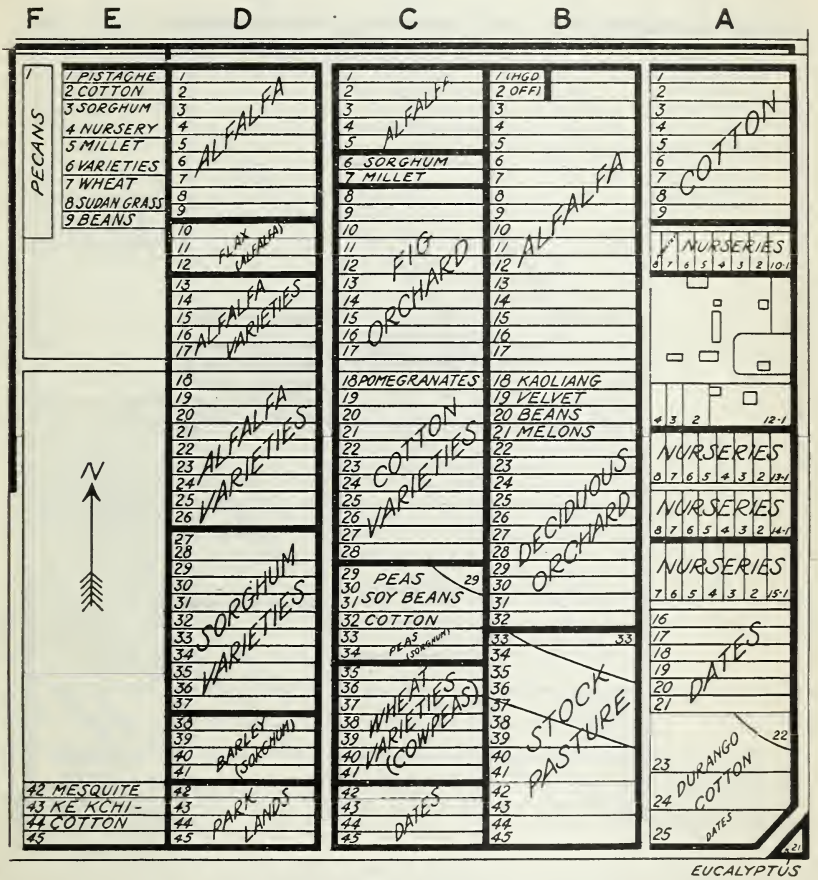

FIG. 2.—Diagram showing the arrangement of the fields and the location of the experiments at the Yuma Experiment Farm in 1919.

not grown in duplicate the results afford a comparison from year to year. The plantings are usually made during the first week in April in rows 44 inches apart and the plants thinned to approximately 12 to 14 inches in the row.

In 1918 all the varieties grown the previous year were ratooned and the results compared with the usual spring plantings.

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[4] The investigational work with cotton in 1919 was carried on cooperatively with the Office of Crop Acclimatization, Bureau of Plant Industry. The service of D. M. Simpson, representing that office, is acknowledged in assembling the results.

The yields of seed cotton per acre for each variety during the 5-year period from 1916 to 1920 are shown in Table 6.

An additional test was made in 1919 in order to experiment on a larger scale with some of the most promising varieties of Upland cotton. This test was made on plats of one-fifth of an acre of fairly uniform soil. As a precaution, to eliminate as much as possible the

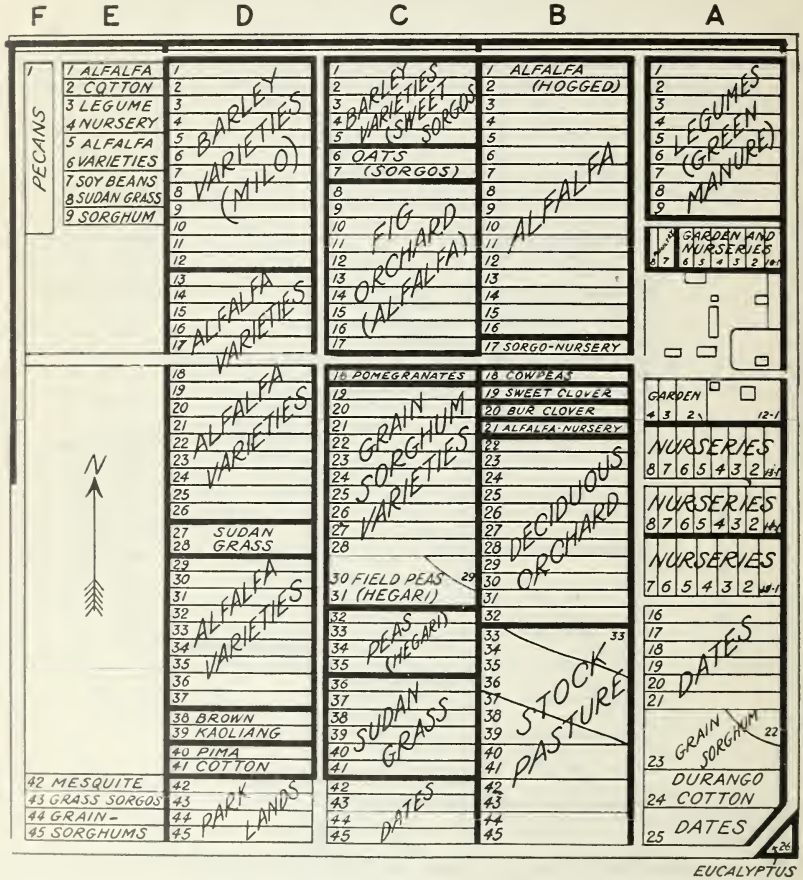

FIG. 3.—Diagram showing the arrangement of the fields and the location of the experiments at the Yuma Experiment Farm in 1920.

factors of soil variation and sequence of crops, one-half of each plat was planted to Durango No. 18 cotton to be used as a check in computing the yields of the other varieties. Outside or border rows were not included in the final yields.

The seed for this test was planted April 8 in rows 44 inches apart. A fair stand was obtained with each variety except the Acala, this block being replanted on May 24. All varieties were thinned to an average of 14 to 16 inches in the row.

TABLE 6.—*Yield of cotton grown on the Yuma Experiment Farm, 1916 to 1920, inclusive, compared with the yields in 1918 of ratooned plats.*

Variety.	Yield of seed cotton per acre (pounds).						Rank in average.
	1916	1917	1918	Ratooned in 1918	1919	1920	Average.	
Pima	.....	2,184	1,442	748	1,785	1,671	1,566	24
Yuma	.....	2,169	2,048	2,384	.....	.....	2,200	3
Gila	.....	.....	1,769	.....	.....	.....	1,769	16
Meade	.....	1,422	1,092	1,669	1,270	1,650	1,421	28
Snowflake	1,007	1,422	1,674	2,098	795	1,885	1,480	26
Sea Island	.....	119	414	342	396	557	366	33
Durango (select strain)	.....	2,022	1,719	2,064	.....	.....	1,935	9
Durango (commercial)	1,761	1,654	.....	1,547	1,280	2,116	1,672	19
Durango No. 18	.....	1,913	1,761	1,387	.....	.....	1,687	18
Foster	1,109	1,787	1,341	914	1,560	2,172	1,480	26
Columbia	1,290	1,767	2,821	1,709	1,570	2,489	1,941	8
Kekchi	917	1,251	1,077	1,267	1,015	1,467	1,166	32
Lewis	1,390	1,668	.....	1,955	.....	.....	1,671	20
Mixson	.....	1,227	1,135	2,406	.....	.....	1,589	23
Acala	2,620	1,808	1,936	1,777	1,310	2,230	1,947	7
Express	1,263	1,907	.....	1,716	1,320	1,932	1,628	21
Tuxtla Early	.....	1,726	1,479	2,056	.....	1,970	1,808	13
Tuxtla Late	1,756	1,028	1,365	1,147	.....	.....	1,324	31
Triumph (Mebane)	1,513	1,361	1,165	1,326	2,390	1,504	1,543	25
Keenan	477	1,375	.....	2,210	.....	.....	1,354	30
No. 624	1,755	1,222	1,158	1,542	.....	.....	1,419	29
Holdon	1,784	1,214	1,866	964	.....	.....	1,457	27
Lone Star	1,216	.....	.....	.....	2,500	2,044	1,920	10
Askew Big Boll	.....	.....	1,846	.....	1,850	2,193	1,963	6
Rowden	.....	.....	2,104	.....	2,240	1,950	2,098	5
Winesap	.....	.....	.....	.....	1,755	1,857	1,806	14
Toole	.....	.....	.....	.....	2,500	2,415	2,450	1
Dixie	2,296	2,620	1,911	2,213	2,110	2,712	2,310	2
King	1,809	1,997	1,356	964	2,220	2,687	1,839	12
Ideal	1,701	1,851	1,576	1,172	1,905	2,285	1,748	17
Trice	1,593	1,794	1,401	1,241	.....	2,063	1,063	22
Cleveland	2,079	1,769	1,401	1,295	2,010	2,600	1,859	11
Half-and-Half	1,972	1,707	1,706	1,812	.....	.....	1,799	15
Sproull	.....	1,634	1,896	2,558	2,320	2,303	2,142	4

Ten irrigations were applied during the season, beginning April 28 and ending October 6. The first picking was made the middle of November and the last in the latter part of December.

The planting arrangment and the yield obtained in pounds of seed cotton per acre are shown in Table 7. A view of the cotton grown in the variety test in this experiment is shown in Figure 4.

TABLE 7.—*Variety test of Upland cotton on the Yuma Experiment Farm in 1919.*

Variety.	Plat No.	Stand per acre.	Yield of seed cotton per acre.
			Pounds.
Durango (commercial)	C–20	8,100	1,185
Durango No. 18	C–21	8,270	1,690
Kekchi	C–21	7,290	1,370
Durango No. 18	C–22	7,522	1,640
Tuxtla	C–22	6,906	1,680
Durango No. 18	C–23	7,670	1,535
Durango (commercial, sold locally as "Rowden")	C–23	7,745	1,700
Durango No. 18	C–24	7,684	1,840
Lone Star	C–24	5,740	1,630
Durango No. 18	C–25	7,561	1,690
Acala	C–25	7,320	1,110

The variety listed as Durango No. 18 is a strain that has been improved by selection and isolation at this station for the last six years. Its behavior, when grown in comparative tests with other Upland cotton varieties, has been very satisfactory. In length of staple this cotton measures from $1\frac{3}{16}$ to $1\frac{1}{4}$ inches. The yields obtained and the fruiting habits of this strain of Durango show a decided improvement over the old commercial type. It is less likely to lodge, has a higher lint percentage, and is easier to pick than the parent variety.

The Acala variety grown in this test is also an extra staple cotton, which varies from $1\frac{1}{8}$ to $1\frac{3}{16}$ inches in length. During the seasons of 1919 and 1920 this variety was grown with good results in the San Joaquin Valley, Calif., and at the Government Date Garden, Indio, Calif.; a yield of over two bales to the acre was recorded at the latter place in 1920.

FIG. 4.—Durango No. 18 and Tuxtla cotton in the variety test at the Yuma Experiment Farm, July, 1919.

In the 1919 test at this station this variety was handicapped by a late start because of the necessity of replanting.

The Kekchi and Tuxtla varieties reported in Table 7 are both extra-staple cottons, which are still in the process of development by the Bureau of Plant Industry. Work is being done to develop and fix the best strains in each of these varieties. The outstanding feature of Kekchi cotton is its high yielding qualities under favorable conditions. In this locality, however, its prostrate-growing habit and the injury by cotton stainers on account of the thin burs interfere with the proper maturing of the bolls. The Tuxtla variety is noted for being very storm proof and having large bolls with thick burs, which resist insect injury. This cotton also opens well at maturity and is easily picked. The chief disadvantages are its tendency to lodge and to shed squares and young bolls when subjected to unfavorable conditions.

The Rowden and Lone Star varieties represent the "Texas Big-Boll" type of cotton. The Rowden seed obtained for this test was obtained locally and proved to be badly mixed with commercial Durango. The seed for planting the Lone Star plat was part of a shipment of pure seed from Cumberland County, N. C. Only a fair stand was obtained on this plat, because of the heavy topsoil.

An early frost, which occurred on October 29, 1919, reduced the yields of all the varieties grown in this test.

In 1920 another extensive variety test was made with Upland cottons planted in alternate four-row blocks. Each block represented an area of approximately one-seventh of an acre. The land used for this experiment (series D, plats 29 to 32) was fairly uniform and productive.

Plantings were made on April 2 in rows 44 inches apart and thinned to an average of 14 inches in the row when the plants were about 8 inches high. The lands were irrigated four times during the growing season.

Table 8 shows the planting arrangement and gives the yields of seed cotton per acre for each variety.

TABLE 8.—*Variety test of Upland cotton in 1920 (4-row blocks) on the Yuma Experiment Farm.*

Variety.	Results per acre.	
	Stand.	Yield of seed cotton.
	Plants.	*Pounds.*
Durango No. 18 (local)	9,954	3,311
Lone Star (local)	9,184	2,723
Tuxtla (local)	9,996	2,912
Acala (California)	9,450	3,367
Lone Star (local)	10,612	3,129
Acala (Texas)	10,654	3,325
Lone Star (local)	9,450	3,066
Triumph (Texas)	9,604	3,143
Lone Star (local)	7,904	2,384
Triumph (University of Arizona)	10,031	2,737
Sproull (Tennessee)	9,576	2,632
Lone Star (local)	10,185	2,324

Pure seed of each variety was used in planting the 1920 variety test. The source of the seed is shown in Table 8. It is also noted in the tabular results of this experiment that the stands were somewhat variable and that the greatest number of plants per acre in most cases produced the highest yields. When compared with the figure 10,183, which represents a perfect stand per acre for cotton planted in rows 3 feet 8 inches apart and thinned to 14 inches in the row, it is observed that on every block except one (Lone Star, local, fourth plat) a good stand was secured.

The factor of soil variation should be considered when comparisons are made between the yields of the varietites. A maximum difference of 805 pounds of seed cotton is noted between the five check blocks of Lone Star (local), whereas the greatest difference in yields between any variety and its adjacent check planting amounts to 588 pounds.

FURROW-AND-BED METHOD.

As a means of controlling the excessive growth of Egyptian cotton on the most productive soils of the project, a system of planting and irrigating known as the furrow-and-bed method has been tested at this station since 1916. The possible advantages to be derived from this method of planting, as stated in the 1916 report of this station,

FIG. 5.—Pima cotton grown by the furrow-and-bed method at the Yuma Experiment Farm, 1919.

are the following: (1) Irrigating to force germination without forming a crust of soil over the seed, thus assuring a stand on hard soils; (2) avoiding an excessive quantity of water during the early irrigations, which tends to produce a large and undesirable vegetative growth early in the season; (3) pickers may, if necessary, return to work in the field very soon after an irrigation by following the high beds; (4) in a late season, when the plant lodges with a heavy crop, it falls on dry beds, thus avoiding the loss from decayed and damaged bolls that results when the ground surface is wet from irrigation water; (5) a more economical use of irrigation water. This method provides for each row the desirable conditions of ample light and air exposure, which are doubtless the chief factors con-

tributing to the development of the superior plants that are always found in outside rows or at the ends of rows of plantings made in the ordinary manner.

The soil of the plats on which these tests have been made is not of that extremely productive type found in other parts of the valley which would give a better comparison between this method and ordinary plantings.

The beds used in this series of experiments were made by listing out deep furrows, varying in certain tests from 6 to 8 feet apart. A light irrigation is given the land through the furrows, to provide the necessary moisture for planting and also to establish a water line on the slopes of the bed. Plantings are made in pairs of rows 24 to 26 inches apart across the furrow, each row being on the side of the bed slightly above the water line. Figure 5 shows a planting of Pima cotton in rows 26 inches apart and the beds 70 inches wide; in other words, the furrows are 8 feet from center to center.

The results obtained from each planting and thinning method for the years 1916 to 1919, inclusive, are presented in Table 9.

TABLE 9.—*Comparative yields of the Pima and Durango varieties of cotton planted by the furrow-and-bed method and the ordinary method on the Yuma Experiment Farm in 1916, 1917, 1918, and 1919.*

Variety and method.	Years.	Distance between—		Date of planting.	Average yield of seed cotton per acre.
		Centers of furrows.	Plants in the row.		
Pima variety:		*Feet.*	*Inches.*		*Pounds.*
Furrow and bed	1919	8	[a] 8	Mar. 28	892
Do	1919	8	[a] 12	...do	703
Do	1919	8	14	...do	1,167
Ordinary	1919		[a] 8	...do	1,325
Do	1919		14	...do	1,255
Furrow and bed	1918	6	16.6	Mar. 18	1,597
Do	1918	7	16.1	...do	1,577
Do	1918	8	17.2	...do	1,347
Ordinary	1918		18	...do	1,593
Furrow and bed	1917	6	15	Mar. 15	1,853
Do	1917	7	15	...do	1,823
Do	1917	8	15	...do	1,753
Ordinary	1917		15	...do	1,586
Durango variety:					
Furrow and bed	1918	8	18.8	Mar. 20	2,070
Do	1918	7	22.6	...do	1,857
Do	1918	6	23.6	...do	1,670
Ordinary	1918		16	Apr. 4	1,549
Furrow and bed	1917	8.5	16	Apr. 13	1,846
Do	1917	7.4	16	...do	1,741
Do	1917	6	16	...do	1,628
Ordinary	1917		16	Apr. 17	2,026
Furrow and bed	1916	8.5	16	Apr. 24	1,610
Do	1916	7.5	16	...do	1,760
Do	1916	7	16	...do	1,840
Do	1916	6	16	...do	1,450
Ordinary	1916		16	Apr. 18	1,761

[a] Deferred thinning.

It is observed in Table 9 that in at least one of the furrow-and-bed plantings of both Pima and Durango cotton a greater yield was

obtained in two of the three years than with the ordinary method of planting. The results as a whole do not vary over a wide range, and this method is not yet to be recommended for general plantings.

One of the chief disadvantages encountered in growing cotton by this method is the difficulty in getting the seed planted in the right manner along the sides of the furrows. It is possible to reconstruct an ordinary 2-row planter to do this work by moving the shoes in to a distance of 26 inches apart. This arrangement makes it necessary to have exactly straight furrows before planting, and the soil must be in almost perfect condition. Foul or poorly leveled land can hardly be planted by this system.

Investigational work involving the manufacture of a combination lister and planter is being continued by the Office of Crop Acclimatization of the Bureau of Plant Industry in cooperation with a company manufacturing agricultural implements.

FERTILIZERS FOR COTTON.

Investigations covering the use of fertilizers on cotton have been confined to limited applications of nitrate of soda, sulphate of potash, acid phosphate, cottonseed meal, and barnyard manure. While the results of this experiment are for one year only and further testing should be done before any definite conclusions should be drawn, it seems quite probable that applications of organic matter in the form of cottonseed meal, barnyard manure, or a green manure will give better results than any of the chemical fertilizers. The yields from the plats treated with acid phosphate were slightly higher than those which received nitrate of soda or sulphate of potash.

In testing the advantage of growing cowpeas as a green-manure crop with cotton in two rows and in the third row cowpeas, it was found that the increase in the yield of the two rows of cotton did not compensate for the loss of the third row.

SELECTION AND IMPROVEMENT OF VARIETIES OF COTTON.

Work has been continued with several strains of Durango, Tuxtla, and Kekchi cotton. Individual selections are made each year, which are isolated and increased in progeny rows. In this manner comparisons are made between the different strains, and a small reserve supply of pure seed is maintained.

On account of the unfavorable results obtained from the Kekchi progenies in 1918 and 1919 further work with this variety has been discontinued.

ALFALFA.

Experimental work[5] with alfalfa during 1919 and 1920 was confined chiefly to hay-production tests. During these two seasons information was obtained regarding the following varieties: Hairy Peruvian, smooth Peruvian, India, Arizona common, Kansas common, Turkestan, Grimm, and Baltic. In yields per acre and adaptability these varieties ranked in approximately the order named. The last four varieties of alfalfa tested failed to make a satisfactory growth during the hot summer months, and these plats were soon badly infested with Bermuda grass and sand burs.

A review of the investigational work with alfalfa varieties which has been conducted at the Yuma Experiment Farm since 1915 shows that the Peruvian types have been foremost in vigor and total yields. The hairy-leaved strain is the most popular one grown on the project and comprises about 70 per cent of the alfalfa acreage.

Preliminary work in testing the use of fertilizers on alfalfa was begun in the season of 1920. Although this test was attempted on a small scale and the results of but one year are available, it seems quite apparent that an application of barnyard manure (10 tons to the acre) or of acid phosphate (300 to 400 pounds per acre) will result in an increased yield of hay.

Alfalfa varieties from different parts of the United States and from foreign countries and various crosses between varieties and individual selections, numbering approximately 350, were tested in nursery rows during 1919 and 1920. The seed from the more promising strains is to be used for further tests and demonstrations.

GRAIN SORGHUMS.

During the past eight years more than 400 different strains and varieties of grain sorghums have been tested at this station. The results of these experiments have shown that, of the total number, less than a dozen varieties are commercially important in the Yuma Valley. Comparative tests have been made from year to year with the more promising varieties, and the results obtained indicate that they rank in importance approximately as follows: Dwarf milo, Dwarf hegari, feterita, Brown kaoliang, Blackhull kafir, Shrock kafir, shallu, White durra, and Pink kafir. The standard grain sorghums on the Yuma project are Dwarf milo, Dwarf hegari, and feterita.

A field of Brown kaoliang grown in one of the test plantings is shown on the title-page.

A very promising kafir hybrid has been bred and selected at this station by the Office of Forage-Crop Investigations. In comparative

[5] Much of the experimental work with the forage crops, including alfalfa, sorghums, and field legumes, has been carried on in cooperation with the Office of Forage-Crop Investigations. Acknowledgment is made of the help of Mr. H. R. Reed, of that office, who assisted in assembling the data on these crops.

tests in 1919 and 1920 this selection yielded 72.7 and 36 bushels per acre, respectively. Further selecting will be continued and demonstration plantings made in different parts of the project.

Past experimental work relating to the cultural methods of grain sorghums has shown that on the light and medium heavy soil of this farm the best returns are usually made from May and June plantings in rows 42 to 44 inches apart with the plants 10 to 12 inches in the row. Low yields are made on the April and early May plantings on account of light, partially filled heads and injury by birds as the grain matures. Feterita and Dwarf hegari appear to be more susceptible to bird injury than Dwarf milo. Most of the grain sorghums mature in 90 to 110 days from planting.

From the standpoint of market value, very little discrimination is being shown between grain sorghums and barley as feed for stock. Most of the grain sorghums are harvested by heading and they are usually marketed and fed locally in this form. Experience has shown, however, that the grain which has been thrashed and cracked has a higher feeding value than when fed in the head.

Dwarf hegari and feterita are preferred as poultry feed. It is also observed that the stalks of these varieties are more readily eaten by live stock than are those of the other grain sorghums.

On account of the number of varieties grown on the project the danger of cross-pollinating from one field to another makes it difficult to maintain a supply of pure seed from field plantings. A distinct advantage to be obtained in planting pure seed is the higher yield as well as the uniform ripening of the crop.

In order to maintain and improve a supply of pure seed of the most important varieties, isolated plantings are made each year from seed selected the previous season. From this supply small lots are distributed to farmers on the project.

FORAGE SORGHUMS.

Forage sorghums as a class have never found an important place in the agriculture of the Yuma project. Most of the plantings have been made for sirup production. These tests have shown that a product of good quality can be obtained only when the sorghum is grown on land carrying a minimum quantity of white alkali. If the soil is excessively salty a salty flavor is imparted to the sirup.

In a limited number of cases forage sorghums are planted as a catch crop to supply a succulent feed for stock. Commercial plantings for seed production have not been attempted.

The results obtained from testing a large number of varieties show that the following sorghums are the best for sirup production or as a forage crop in this locality: Gooseneck ("Texas Seeded Ribbon"), White African, Honey, Java, Collier, and Sumac.

WINTER GRAINS.

Five kinds of bearded barley have been grown in a variety test at this station for two seasons. Because of soil variation it is difficult to make direct comparisons between the yields for one year; however, the average for the two years gives an indication of the adaptability and yielding qualities of each variety. The grain in these tests was seeded in December at the rate of 60 pounds to the acre and harvested in April and May. Before planting, the grain was treated with formaldehyde (1 pint to 40 gallons of water). This treatment proved to be entirely effective in controlling smut.

The Smyrna and Hannchen varieties included in these tests are 2-row barleys and the others belong to the 6-row type. In point of maturity the 2-row barleys ripened from 10 days to 2 weeks earlier than the Mariout and about 3 weeks before the Coast variety.

TABLE 10.—*Tests of barley varieties at the Yuma Experiment Farm in 1919 and 1920.*

Variety.	Yield per acre (bushels).		
	1919	1920	Average.
Smyrna (C. I. No. 910)	24.0	35.7	29.8
Hannchen (C. I. No. 531)	17.8	23.5	20.6
Coast (C. I. No. 690)	21.4	30.5	25.9
Mariout (C. I. No. 261)	29.5	30.6	30.0
Trebi (C. I. No. 936)	9.4	26.2	17.8

Heretofore barley has been grown on the project mostly for hay, the grain being cut just before it reaches maturity. It is believed, however, that barley will be sown more extensively in the future as a grain crop and will find a permanent place in a crop-rotation system of farming.

The varieties grown in these tests and the yields obtained for each year are given in Table 10.

WHEAT.

Experiments with wheat have been confined to varietal tests covering a period of two years. The cultural methods employed in growing this crop are practically the same as for barley. Sowings are made in December and the grain harvested in May.

TABLE 11.—*Tests of wheat varieties at the Yuma Experiment Farm in 1919 and 1920.*

Variety.	Yield per acre (bushels).		
	1919	1920	Average.
Early Baart (C. I. No. 1697)	22.5	17.7	20.1
Sonora	21.3	27.7	24.5
Durum	20.0	19.2	19.6
Kanred (C. I. No. 5146)	25.7	10.5	18.1
Defiance		12.6	12.6

The varieties grown and the respective yields in bushels per acre for the years 1919 and 1920 are shown in Table 11.

Of the varieties listed in Table 11, the Early Baart is the first to mature, the Defiance, Sonora, Durum, and Kanred following in the order named. The yields of all varieties except the Kanred are shown to be fairly consistent for each year. The exception in the case of Kanred is probably due to the difference in climatic conditions at the time of maturity. This variety has the disadvantage of being nearly three weeks later than the others and in ripening at a time when both the maximum and minimum daily temperatures are quite high. A plat of Kanred wheat is shown in Figure 6.

FIG. 6.—Kanred wheat grown in a variety test at the Yuma Experiment Farm in 1920.

It is important that winter grains be well supplied with moisture at all times until the grain is nearly ripe. Light, shriveled grain and a low yield are often caused by the lack of late irrigation.

FLAX.

Beginning with the year 1914 there has been conducted at the Yuma Experiment Farm a series of experiments with flax for seed production. This work has covered the testing of varieties, methods of planting, and the time and rate of seeding. Although this crop has never been commercially important in this region, sufficient information has been obtained from these experiments to indicate its possibilities as a profitable crop under certain conditions.

Tests which were made with over 20 varieties to determine their seed-yielding qualities and their adaptability to this climate show that about eight of them may be grown with fair success. A list of these varieties and the yields recorded in 1919 are given in Table 12.

TABLE 12.—*Yields of flax varieties at the Yuma Experiment Farm in 1919.*

Variety.[a]	Yield per acre.	Variety.[a]	Yield per acre.
	Bushels.		*Bushels*
C. I. 102, Lineta	18.7	C. I. 25, Williston Golden	14.5
C. I. 149, Selection 27-5 from Nova Rossisk.	17.6	C. I. 30, Smyrna	14.3
C. I. 151, Selection 44-5 from La Plata, C. I. No. 44	17.3	C. I. 27, Nova Rossisk	12.4
C. I. 20, Punjab	16.0	C. I. 3, Damont	11.1

[a] Varieties of flax are identified by numbers given them by the Office of Cereal Investigations of the Bureau of Plant Industry.

Planting flax seed in rows 18, 20, 22, and 30 inches apart has been compared with broadcasting, and the results of these comparisons show that the latter method is usually the better. In cases, however, where plantings are made on a heavy soil which forms crusts around the stems of the plants, flax planted in rows and cultivated after each irrigation will yield better than if sown broadcast.

Time and rate of seeding experiments have shown that late December or early January is the optimum date for planting and that a seeding rate of 40 pounds to the acre usually returns the highest yield.

LEGUMES.

An extensive series of tests extending over a period of seven years has been conducted with a large number of legumes to determine their relative value as forage, green-manuring, and seed-producing crops. There is little value to any legume grown as a forage crop in this region except alfalfa. There is, on the other hand, an increasing interest being taken in the use of legumes as green-manuring crops. As mentioned in previous reports of this station, beneficial results have been obtained, especially on the sandy and medium-light soils, wherever a leguminous crop has been plowed under. The cost of irrigation water and the price of seed have been the chief objections in the past to this method of maintaining or increasing soil fertility. The acreage on the project devoted to the production of seed for green-manure crops is very limited.

The legumes which may be grown during the winter are field peas, vetches, sweet clover, sour clover, bur clover, and berseem (African clover). Variety tests which have been made with more than 50 kinds of field peas have shown that the Amraoti, Bangalia, Scotch Blue, and Liberty varieties are the best for this locality. The first two make the best seed yields, averaging 10 to 15 bushels per acre. The others make the best growth for forage or green-manuring purposes.

Vetches that have been grown in test plats include the common, sand, hairy, bitter, and purple varieties. As a class these legumes have so far appeared to be inferior to field peas for all purposes.

All the clovers which have been mentioned in this class of legumes, while having many points in their favor as green-manuring crops, can hardly be used extensively on account of the danger of volunteer plants mixing with other seed crops. The alfalfa seed crop, which is one of the major industries of the project, would be seriously affected by the presence of these other seeds. Berseem, an introduction from Africa, has been grown in nursery rows for two years. Additional plantings on a larger scale will be made with this crop.

Included in the great variety of summer legumes which may be grown under field conditions in this section of the country are cowpeas, soy beans, tepary beans, jack beans, velvet beans, hyacinth beans, chick-peas, and peanuts. For most purposes cowpeas are generally planted, and the varieties which are usually grown are Whippoorwill, Groit, Blackeye, Brabham, and the Early Buff.

ORCHARD FRUITS.

DATES.[6]

Investigational work with dates has been confined chiefly to the fruiting of seedlings. Seed of nine promising varieties was planted in 1911, 1912, and 1913. The total number of seedling date palms growing on the experiment farm in 1920 is 6,670. Of this number, 3,570 are still in nurseries, 1,400 are planted along the roadways, and 1,700 are placed in orchard positions. The records during the past year show that of the 703 palms that bloomed 478 were male and 225 female trees. The fruit of 12 trees was of good quality, that of 29 fair, but the remainder were late-maturing trees with dates of an inferior grade.

With an increase in the number of promising dates that have fruited, investigational work will be continued to include the transplanting of offshoots. It is also contemplated to experiment with different methods of artificial ripening of the fruit to improve the quality of the inferior grades.

FIGS.

In 1912, 1,600 seedling figs which were crosses between the Smyrna and common varieties were planted. The purpose of this test was to obtain, if possible, some new varieties which would have the excellent qualities of the Smyrna but would not need insect pollination to set fruit, as required by that variety.

The results of eight years' work with this test show that 384 trees, or 24 per cent, produced mature fruit. Of this number there were 62 which had fruit ranging from fair to good in quality. Up to the present time the quality of the fruit from the seedlings has been inferior to that from the trees of named varieties.

[6] Persons who are interested in date culture in the Southwest will find much information in Farmers' Bulletin 1016, "Propagation and Culture of the Date Palm," by Bruce Drummond.

Of the 12 varieties of Adriatic figs grown, the Brown Turkey and Black San Pedro have produced the best results. The fruit of these two varieties is large and the quality very good. The Celestial is an early-ripening fig and very productive, but the fruit is small. In 1919 one of the foreign figs which is listed under S. P. I. No. 6952 produced its first crop of fruit. This particular fig is larger than that of any other variety in the orchard, besides being of good quality and very prolific.

An attempt was made in the spring of 1919 to establish a colony of the fig insect (Blastophaga) in the orchard, but without success. A later effort, however, which was made in August of the same year was more successful. The insects succeeded in wintering over and were present in large numbers during the season of 1920. The effect of insect pollination was particularly noticeable on those trees which had failed to mature a crop of fruit in previous seasons. While the presence of this insect caused a large crop to be obtained from the orchard, the quality as a whole was not improved. Many of the seedling trees developed more of a caprifig characteristic when acted upon by the Blastophaga.

DECIDUOUS FRUITS.

A large number of assorted varieties of deciduous fruit trees were planted on the experiment farm in 1913 and 1914. The task of maintaining an orchard in this area during the intervening years has constituted a serious problem on account of the loss of bearing trees. Whether this dying condition is due to the shallow soil, depth of underground water, a bacterial or fungus disease, or to the alkali or other substances in the soil has not yet been determined. Trees of apricots, plums, and peach varieties 4 and 5 years old appear to be most susceptible to this adverse condition, although some pear and apple trees also have been killed.

The planting in 1914 included several Davidiana (wild Chinese) peach trees. It was hoped that this variety would prove to be hardy and desirable for root stock on which almonds, peaches, and apricots might be budded. Seed from these trees was to be tested for that purpose. It appears, however, that the Davidiana is also susceptible to this adverse condition. A typical case of this loss of older trees is shown in Figure 7.

The deciduous fruit and nut varieties which have appeared to be well adapted to local conditions are the Japanese persimmon, quince, pomegranate, jujube, pear, fig, almond, and pecan.

Other fruits which may be considered as possibilities are olives and in some instances citrus fruits. Investigational work with citrus fruits, including the testing of varieties on different roots, is being continued.

SMALL FRUITS.

The rapid development of the grape industry in the Southwest has caused considerable local interest in the growing of early grapes for table use. There has already been established in the Imperial and Coachella Valleys of California a substantial industry based on the growing of early grapes, a large proportion of which is shipped to eastern markets.

The acreage of vineyards on the Yuma project is still very small, and while it is unlikely that any considerable area will be planted there will be an increase in those sections where the conditions are the most favorable.

In a test conducted at the experiment farm with 26 varieties of grapes, the most encouraging results have been obtained from the

FIG. 7.—Davidiana peach trees planted in 1914, showing the typical loss of older trees on the Yuma Experiment Farm. Photographed September 23, 1920.

Thompson Seedless and Malaga. The average date of ripening for these two varieties has been June 30 and July 24, respectively. Other varieties which have done very well in the adjacent irrigated valleys are the Khalillee, Black Monukki, Red Malaga, and Persian No. 23. Grapes, other than these early varieties, are hardly adapted to this region. The yields are low and the fruit does not ripen uniformly.

Investigational work with strawberries has shown that the possibilities of production on a commercial scale are very limited. In the test of 13 varieties it was found that all made an excellent growth in the spring and early summer, but later in the season a large percentage of the plants died. This loss is probably due to the excessive

summer heat and to the alkali in the soil. The Early Ozark appeared to be hardier under local conditions than any of the other varieties. The plants of all varieties in this test were set out in January and February.

VEGETABLES.[7]

Experimental work with a large assortment of garden vegetables has been carried on for eight years. Variety tests, experiments with cultural methods, and date-of-seeding tests have been made from year to year on practically all vegetables which have been recommended for this region by reliable seed houses. The list of the truck crops which have been grown and upon which reports have been made are asparagus, beans, beets, cabbage, carrots, casaba melon, cantaloupe, cauliflower, chick-peas, popcorn, sweet corn, cucumbers, eggplant, fenugreek, garlic, kohl-rabi, lettuce, muskmelon, okra, onions, parsley, parsnips, peas, peanuts, peppers, potatoes, radishes, roselle, spinach, squash, sweet potatoes, tomatoes, turnips, and watermelons.

The station reports for 1917 and 1918 include the major portion of all data on garden vegetables. These results are briefly summarized here.

Asparagus.—Asparagus is well adapted to this locality and thrives well on soil carrying a moderate proportion of white alkali. The plants may be readily propagated from seed, which should be planted in February or March. The seedlings should be transplanted when 1 year old to rows 5 feet apart and the plants placed 2 feet apart in the row. From two to three years' time is necessary to allow the plants to become well established. The Giant Argenteuil variety is the best for this region.

Beans (green).—For green-vegetable use, the Stringless Green Pod variety is the only one of the many tested that produces green beans of the best quality.

Beans (dry).—The three kinds of dry beans that are grown commercially on the project are the pink, tepary, and Blackeye varieties. A crop of beans may very often be planted in early April and harvested before being damaged by the intense summer heat, or it may be planted about August 1 and a fair yield obtained before frosts occur.

Beets.—The Early Model and Blood Turnip are the prominent varieties of beets grown in the winter garden.

Cabbage.—The best results with cabbage are obtained by planting in beds during the early fall and transplanting to ridged beds 3½ feet between furrows. The plants are placed at the water line 24 inches

[7] The experimental work with fruits, vegetables, and ornamentals is under the immediate supervision of C. E. Peterson, assistant, who has compiled the figures herein reported.

apart along the side of the furrow. The Early Winningstadt, All Season, and Early Drumhead varieties have done well.

Carrot.—About the same cultural treatments should be given carrots as beets. Plantings can be made the latter part of September. The Oxheart variety is the most satisfactory one tested.

Casaba melon.—The cultural methods followed in growing casaba melons are practically the same as for watermelons. The Honey Dew and Improved Hybrid are the favorite varieties grown.

Cauliflower.—Only fair results have been secured from cauliflower plantings. The seed is started in beds the same as for cabbage and transplanted to the garden in late October. Best Early and Dry Weather are two good varieties.

Chick-pea.—Autumn plantings of chick-peas, or Mexican garbanzos, are somewhat preferable to those made in the spring. Only light yields have been made in all tests with different varieties.

Corn (pop).—Satisfactory yields have never been obtained from any of the many pop-corn varieties tested.

Corn (sweet).—The best results are usually obtained from plantings of Papago sweet or Mexican June corn. This crop may be planted from early spring to late summer. The corn earworm and smut reduce the yield of all corn varieties.

Cucumber.—Cucumber plantings should be made in late January or early February on medium heavy well-drained loam soil on ridges about 5 feet wide, with the plants 3 feet apart along both sides of the ridges. The best varieties tested have been the White Spine and Long Green.

Eggplant.—Seedling plants are started in the hotbed and transplanted to the field much the same as for tomatoes. The Black Beauty and New York Spineless are reliable varieties of eggplant.

Fenugreek.—A fall planting of this beanlike legume made in 1918 produced at the rate of 6.81 bushels per acre of mature seed the following June.

Garlic.—Either the entire bulb or the bulblets, or cloves, of which the bulb is composed, may be planted. The land should be prepared in ridges or beds 3 to 3½ feet across and the plantings made in rows on each side of the bed. The time of planting and the cultural methods are similar to those required for the production of onions by sets.

Kohl-rabi.—The White Vienna is the best variety of kohl-rabi tested, and the manner of growing is the same as for cabbage, cauliflower, and kale.

Lentils.—Profitable yields of lentils have not been obtained from plantings of this bean.

Lettuce.—All varieties of lettuce grow well in this region, but the head types are most important. The New York, Iceberg, and Prize Head varieties do exceedingly well. The best results are obtained on rich loose soil, with the plantings made on ridges.

Muskmelon.—Cultural treatments for muskmelons are the same as for watermelons. The Emerald Gem may be grown for early home use, while the Rocky Ford produces a larger yield.

Okra, or gumbo.—When planted in April, green pods for table use may be picked during the summer and early fall months.

Onions.—Rather extensive tests have been made in past years of the important phases of onion production. Of all the varieties tested the White Bermuda and Crystal Wax were the most successful. It has been demonstrated that no particular advantage is to be derived from the practice of transplanting from seed beds as compared with ordinary plantings in the field rows. Onions may be planted in two ways, (1) on the flat in rows 12 to 15 inches apart to be cultivated with hand tools or 24 inches apart if a horse cultivator is used, (2) on beds with furrows 3 feet apart with two or three rows of onions in each bed. Onion seed is produced by planting the bulbs in the early fall in rows on the top of ridges and placed 3 inches apart in the row. A comparative test with local and imported seed demonstrated in practically every case the superior quality of that grown locally.

Parsnip.—While this vegetable may be grown with fair success, the quality is inferior to that produced in northern climates.

Peas.—Early dwarf varieties of green garden peas when planted in September will quite often develop for picking by the end of November. In a test conducted during 1916, 1917, and 1918 the following varieties were reported to be the most promising: Pride of Cahuenga, Yorkshire Hero, Dwarf Telephone, Premium Gem, and Little Marvel.

Peanuts.—The Spanish peanut is very suitable for growing on the light sandy loam soils of the project. The nuts of this variety are small, but the yields are better than the Tennessee Red or Virginia Bunch varieties.

Peppers.—Plantings are made in the same manner for peppers as for tomatoes or eggplant. Both the sweet and the hot peppers grow exceedingly well. The sweet varieties are the Chinese Giant and the Bell; the hot variety, the Anaheim.

Potato.—It is only in rare instances that profitable yields have been secured from plantings of Irish potatoes. The difficulty in securing good seed and the climatic and soil conditions are the chief difficulties in growing this crop. Of the varieties tested the Irish Cobbler has been the best, but seed of this kind is not always obtainable. Other suitable varieties for this region are the following, in the order named: White Rose, Red Triumph, and Early Ohio.

Pumpkins and squash.—These vegetables may be grown with about the same treatment as for watermelons. The Large Cheese and the Cushaw are reliable pumpkin varieties, the former very often being grown for stock feed. Winter squashes, on account of sunburn and

aphids, do not grow as well as the summer squash. The Mammoth White Bush Scalloped is the best kind tested.

Radish.—Quick-growing varieties of radish in the winter garden are the best for this region. Of the small red radishes the Scarlet Turnip and Scarlet Globe are good. The White Icicle and Japanese Winter are the best white varieties.

Roselle.—Seed should be sown April 1 in the field, on beds 6 feet apart and spaced 4 feet apart in the row.

Spinach.—Spinach is grown in about the same manner as lettuce. Frequent irrigations are necessary to produce a crisp, tender growth. The Prickly Seeded or Winter variety is the best that has been tested.

Sweet potato.—For sweet potatoes a rich sandy soil is preferred, and the ground should be prepared by plowing ridges from 3 to 3½ feet apart, setting the plants in rows on one side of the ridge, and spacing them every 12 to 15 inches. When the plants are well established and the runners have started, the soil should be worked to the plants on the furrow side of the row by plowing from the adjoining ridge. This locates the plants finally in the center of the ridge. Of the varieties tested the White Vineless gives the best results. The Yellow Nansemond and Porto Rico Yam are also recommended.

Tomato.—Results covering the work of a number of years with tomatoes show that the best yields were obtained when grown under the following conditions: (1) A light silt or sandy soil which has been well manured; (2) land should be avoided which has been in tomatoes the previous year, on account of diseases which may live over the winter in the soil; (3) seed should be planted in paper pots in a hotbed and transplanted later to the field when all danger of frost is over; and (4) in preparing the field for planting, ridges 5 feet wide are plowed up, leaving furrows between. The plants are placed on one side of the ridge, 3 feet apart for the dwarf varieties and 4 feet apart for the tall kinds. When the plants are well rooted the soil should be plowed to them, filling the furrow and leaving the tomatoes near the center of the bed. The new intervening furrow remains open for irrigation purposes. A number of varieties are adapted to this locality, the most important of which are First Early, Matchless, Chalk's Early Jewell, Earliana, and John Baer.

Turnip.—This vegetable is easily grown in the winter on any good garden soil. The Golden Ball, Snowball, White Milan, and Purple Top Strap Leaf varieties have been found to do well.

Watermelon.—The best preparation of ground for planting watermelons consists of plowing ridges 8 feet wide, leaving a well-formed furrow between for irrigating, and affording dry soil on the ridge for the support of the vines and melons later in the season. Land

laid off in an east-to-west direction with the seed planted on the south side of the ridge affords a warm exposure and promotes early germination of the seed. Earliness may be increased by planting about January 15 and covering each hill with oiled paper. Many varieties do well here but vary as to quality. Those found to produce the best yields and fruit of good quality are the Black-Seeded Chilean, White-Seeded Chilean, Kleckley Sweet, and Klondike.

FIG. 8.—Pasturing sheep on ditches, Yuma Experiment Farm, July, 1919.

TABLE 13.—*Summary of comparative results of feeding hogs on alfalfa pasture with a 2 per cent grain ration at the Yuma Experiment Farm, 1916 to 1920, inclusive.*

Item of comparison.	1916	1917	1918[a]	1919	1920	Average.
Spring period:						
Area of plat.....acre..	0.25	0.75	.....	0.75	0.75	.....
Number of hogs.....	6	16	.....	8	10	.....
Number of days.....	56	120	.....	121	132	107
Total initial weight.....pounds..	345	926	.....	450	567	.....
Total final weight.....do..	596	2,328	.....	1,176	1,442	.....
Total gain.....do..	251	1,402	.....	726	875	.....
Average daily gain per hog.....do..	0.75	0.73	.....	0.75	0.66	0.72
Total grain fed.....do..	527	3,905	.....	1,809	2,593	.....
Grain per pound of gain.....do..	2.1	2.8	.....	2.3	3.0	2.55
Summer period:						
Area of plat.....acre..	0.25	0.75	0.75	0.75	0.75	.....
Number of hogs.....	6	12	11	7	14	.....
Number of days.....	126	98	119	69	56	93.6
Total initial weight.....pounds..	426	462	417	581	320	.....
Total final weight.....do..	1,020	1,360	1,056	865	599	.....
Total gain.....do..	594	898	639	284	279	.....
Average daily gain per hog.....do..	0.79	0.76	0.49	0.59	0.33	59.8
Total grain fed.....do..	1,822	1,786	1,753	1,122	484	.....
Grain per pound of gain.....do..	3.1	2.0	2.7	3.9	1.73	2.68
Total season:						
Number of days.....	182	218	119	190	188	179.4
Total gain.....pounds..	845	2,300	639	1,010	1,154	.....
Pork produced per acre.....do..	3,380	3,067	852	1,347	1,539	2,037

[a] No tests were made in the spring of 1918.

LIVE-STOCK EXPERIMENTS.

Experimental work with live-stock production has been confined to pasturing tests of hogs on alfalfa (1916 to 1920), hogging-off field peas (1916), hogging-off milo and barley (1917), a Bermuda grass pasturing test with steers in 1916, and the use of sheep on ditch banks to control weeds and grass.

PASTURING HOGS ON ALFALFA.

In this region with a mild climate, a long pasturing season, and fairly cheaply grown grains, pork production should become increasingly important. Experiments which have been made at this station each year since 1916 with hogs on alfalfa indicate the probable results to be expected from using a pasturing and supplementary grain-feeding method.

Fig. 9.—An irrigation ditch that has been pastured by sheep, Yuma Experiment Farm, 1920.

The usual practices followed in pasturing alfalfa are to pasture second-year or older alfalfa and have the fields divided into two or three lots, in order to insure convenience in irrigating and to prevent overgrazing of the pasture. Close pasturing or overpasturing should be avoided, because a stand of alfalfa is thus crowded out by Bermuda grass.

A 2 per cent grain ration (cracked grain sorghum or rolled barley, 2 pounds per 100 pounds of pig) will usually produce a vigorous and thrifty stock hog. If it is desired to fatten the hogs as quickly as possible while on pasture, a 3 or 4 per cent grain ration should be fed or a self-feeder

used. As the feed is increased from 2 per cent to full feed the area of alfalfa pasture used is correspondingly decreased.

Hogs on pasture in these tests were fed once a day, at evening time. Plenty of shade, clean drinking water, and a good mineral mixture were provided at all times.

The results from pasturing alfalfa and feeding a 2 per cent grain ration for the years 1916 to 1920, inclusive, are given in Table 13.

PASTURING SHEEP ON IRRIGATION DITCHES.

Demonstrations as to the value of pasturing sheep on irrigation ditches have been made at the experiment farm and in other parts of the project for some years. The control of the vegetative growth (which means the depositing of much less silt) and its use as a source for producing additional revenue from wool and mutton are the chief advantages of this practice. A view of the sheep on one of the large ditches on the experiment farm is shown in Figure 8. A comparison between pastured and unpastured ditch banks is presented in Figures 9 and 10.

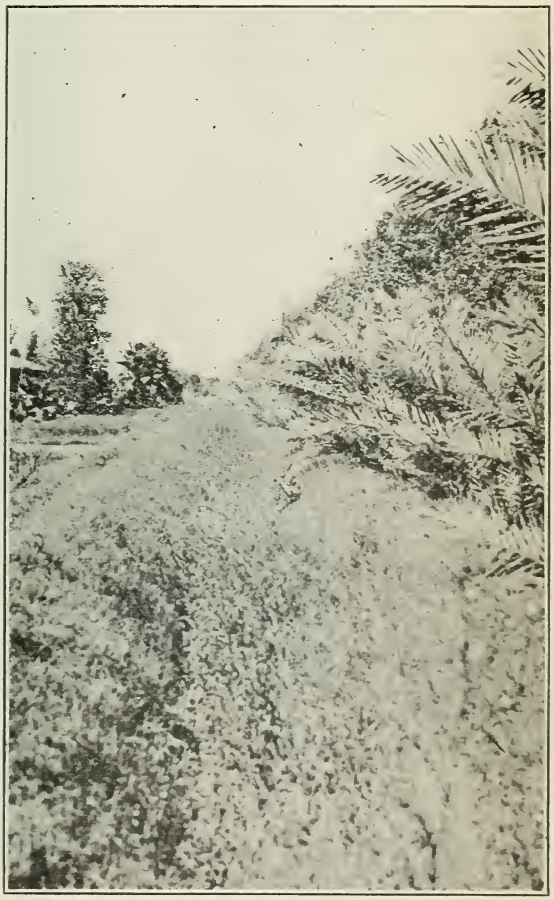

FIG. 10.—An irrigation ditch not pastured by sheep, Yuma Experiment Farm, 1920.

The flock used in this work consisted of 14 ewes of mixed breeding and one pure-bred Shropshire ram. The crossing of this ram with the native ewes resulted in a lamb very desirable for mutton purposes.

The cost of fencing materials and the losses by sheep-killing dogs have been the chief drawbacks to the use of more sheep on the project farms.

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